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Improvement in Taif Roses' Perfume Manufacturing Process by Using Work Study Methods: A Case Study

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ABSTRACT

Work study is a catch-all phrase encompassing a variety of methodologies, including method research and work measurement, that are applied in a variety of contexts and lead to a systematic assessment of all elements that affect the efficiency and economy of the situation under evaluation that is meant to be improved. The main aim of this study is to examine and enhance the process token in manufacturing a Perfume of the famous, well-known, aromatic, and beautiful Taif Roses. Some changes in the process has been suggested using method study and time study method which lead to reduction in process time, labor cost and production cost.

Keywords: *Work study; Taif Roses' perfume; Time study; Plant layout; Method study; Productivity.*

INTRODUCTION

International Labor Organization defines work study as the technique of method study and work measurement employed to ensure the best possible use of human and material resources in carrying out a specified activity [1]. It is also a management service based on method study and work measurement used in examination of human work leading to investigation of all the resources that effect efficiency and economy of situation to affect improvement. Further ILO states that work study is to minimize cost either by designing the work for high productivity or by improving productivity in existing work through improvements in current methods by reducing ineffective and wasted time. Productivity improvement can be done by sorting of elimination, repairing of ineffective process, simplifying the method, optimizing the system, reducing variation, maximizing turnout up quality or responsiveness and reducing set-up time. Productivity can be also achieved by increasing the value-added content of products [2]-[5], or by decreasing the unit cost of production or decreasing the work content of the production, or line balancing of the production line or by a combination of all [6]-[10]. Productivity improvement is the continuous improvement process of any types of activities [11],[12].

It is known for Taif city to be the "City of Roses" and for its roses as a famous landmark. Most tourists go to the rose fields to see it and enjoy its beauty especially in the Taif roses' festival at Taif roses' season Between March and April, at the time of bloom. We are thrilled to investigate roses' industry that reflect our heritage, loyalty, and love of our hometown. Therefore, as Taif city being well known for its roses, and their fragrant smell, we were promoted to shed light on the Taif Rose perfume industry, and the massive local efforts of manufacturing roses' perfume. However, pursuant to the 2030 vision of the Kingdom of Saudi Arabia for local manufacturing "MADE IN SAUDI" we desiderated to help developing Taif city's manufacturing.

From this perspective, this study has been done to study the manufacturing of such a precious industry. This study began with observing and recording the sequence of operations in the production line and understanding them well,

then recording observations using recording techniques. After that, some improvements were proposed, and the time studied to reduce the time wasted in the unnecessary movement of workers in the factory. Using the methodology of method study for the movement of the workers and machines inside the factory, and the procedure of time study for the required time for each work element and for the total production. Then, suggest modifications to minimize the total time, effort, and waste and to maximize the production and profit (efficient and effective).

1. APPLYING WORK STUDY PROCEDURE

In this step we will observe and record the process of how Taif roses' perfume is made in a factory and how to improve this process. analyze the work in order to achieve work simplification and thereby improving productivity of the system.

1.1. Method Study

The main aim of method study is to examine the process and to find more efficient methods of performance, so the process is simplified, and better ways are developed. The procedure followed for method study Design or (Motion Study) is done using the steps below:

- Select the process to be studied/analyzed and define objectives to be achieved by method study.
- Record all relevant facts or information pertaining to the existing method using the recording techniques.
- Examine all the recorded data information (critical questioning; purpose, place, sequence, person, and the means of doing the process.
- Modification and improvements in current data (which method is practical and economical to find /Develop new OR alternative OR best method under prevailing circumstances.
- Measure the work content and establish the standard time using an appropriate work measurement technique.
- Define new method(s) for the process/operation.
- Install and maintain the new method.

The selection step was done due to the value of Taif Roses' Perfume Manufacturing process and the method study objectives are to examine and analyze the manufacturing process and to search enhancements in the process. After that, moving in recording step, we saw that the most suitable recoding techniques are Flow Process Chart, Multiple Activity Chart, and Flow Diagram. The techniques and their implementations are present here.

1.1.1. Select

This step is one of the most important tasks. In this step to select appropriate job, activity, or situation for method analysis and mainly it is a managerial responsibility Practically any activity is a potential project for improvement but only those jobs should be selected when there are some valid reasons for method study (like job/activity is unpopular or considered dirty by workers). Maximum cost benefit is the normal objective. In this study we selected 3 main factors to work on. The first factor is the process of manufacturing the Roses and especially how workers perform their tasks. The other factor is the machines involved in the process and how they function optimally. The last factor we selected is the layout of the factory and how the workplace is designed.

1.1.2. Record

The recording step is mainly about obtaining facts about the present method and recording these facts. In order to improve an activity or procedure the factual information is collected from the place where the job under evaluation is being executed by direct visual observation.

Recording is done using:

1. Recording movement of machines or materials.
2. Recording the critical procedure in the job.
3. Recording the operator's performance.
4. Recording the path of movement of workers, machines, and allied operations.
5. Recording the path of movement to improve workplace layout.

There are several standardized techniques including charts, diagrams, graphs, and other techniques that are available to be used for proper recording and presentation for further analysis. The choice of technique depends on the type of information which is to be recorded. Having this in mind, our choice settled on three techniques of recording.

The techniques used in this study:

1. Flow Process Chart.
2. Multiple Activity Chart (Man-Machine Chart).
3. Flow Diagram.

1.1.2.1. Information Collection

In the process of conducting work study of the Taif roses' perfume manufacturing process, we visited Alkamal Roses' Factory to implement the study upon it. As we observed the manufactoring process we filmend a video clip showing every process and movement made by the worker during the work, as well as the time it took for the worker to complete each of the tasks.

The video helps determine the time consumed using one of the time measurement strategies, which is stopwatch. As for the manufacturing steps, they consist of seven main steps mentioned below, and shown in Figure 1 which will be studied in detail later.

1. Picking roses (takes 660 minutes).
2. Counting and weighting (takes 9.38 minutes).
3. Filling the pot and pressing by hand (takes 1.33 minutes).
4. Pouring rose water into the pot (takes 0.5 minute).

5. Closing the pot (takes 0.09 minute).

6. Distillation (takes 960 minutes).

7. Separating perfume from rose water (takes 0.23 minute).

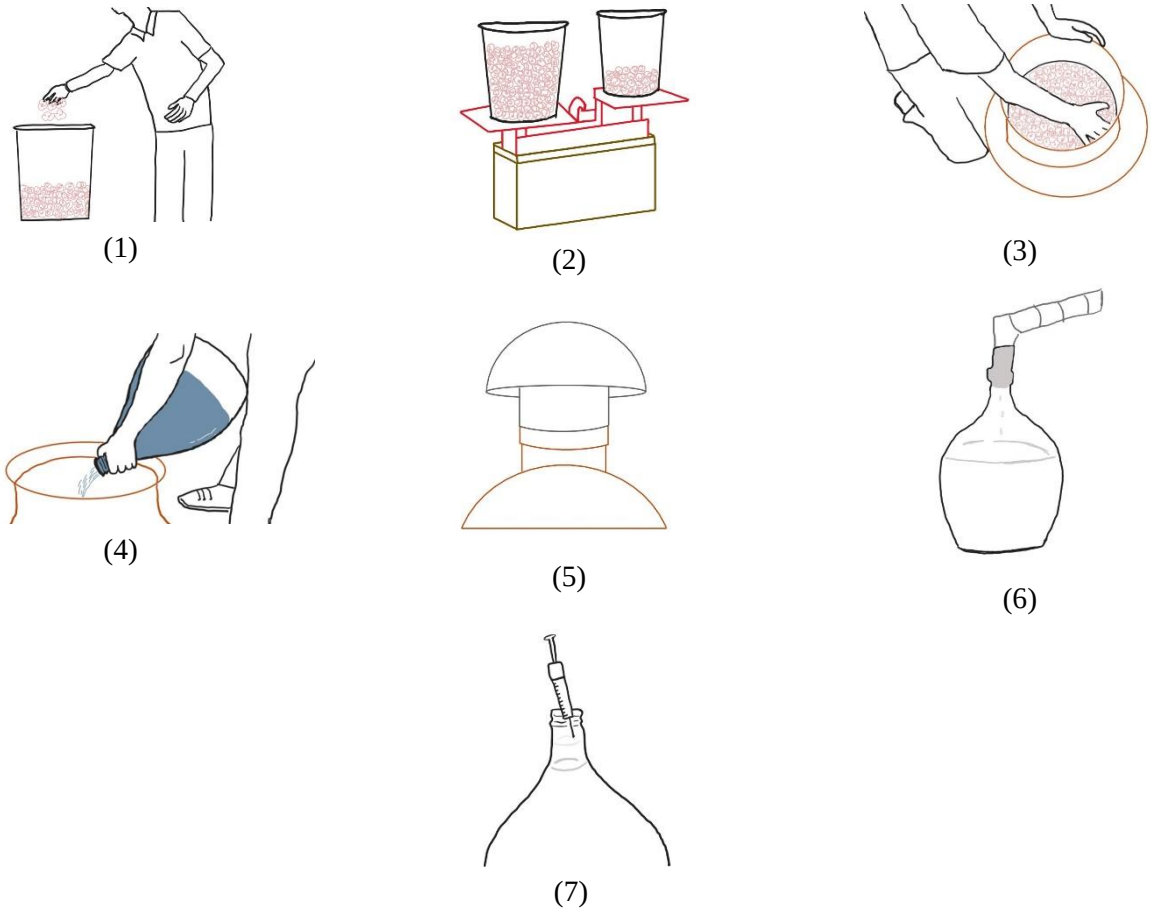

Figure 1. The manufacturing steps

1.1.2.2. Flow Process Chart

Flow process chart is a graphical and symbolic representation of the activities performed on the work piece during the operation, it's often used when observing a physical process to record actions as they happen, and thus get an accurate description of the process also, analyzing the steps in a process, to help identify and eliminate waste. In our study, we are using Flow Process Chart as the recording technique to record Taif Roses' perfume manufacturing process.

Standard use of Flow Process Charts:

• Operation: to change physical or chemical characteristics of the material.

• Inspection: to check the on material or process, the quantity for example.

• Transport: transporting the material from one place to another.

• Delay: situation where to cause someone or something to be late or slow.

• Storage: when the material is kept in a location (storage places).

Flow Process Chart				Worker/Material/Equipment Type				
Chart No. 1 Sheet No. 1								
Subject charted: work study of Taif Roses' perfume manufacturing process				Activity		Present	Proposed	saving
Activity: Taif Roses' perfume manufacturing process				Operation	O	27		
				Transportation	⇨	4		
Method: Present /Proposed				Delay	D	1		
Location: Al-kamal factory, Taif				Inspection	□	5		
Operative(s): Clock No.				Storage	▽	2		
				Total		39		
Charted by: Samar Alharthi Date: 19/4/2022				Distance (m)		44		
				Time (min)		1637.76		
Approved by: Lojain Alsufyani Date: 19/4/2022				Cost				

Description	Qty.1 Case	Distance(m)	Time (min)	Symbol					Remarks
				O	⇨	D	□	▽	
Bring basket from basket area	1		0.04	•					
Move to the field of roses		16	2.42		•				
Wear gloves	2		0.13	•					
Picking roses (Picking process)			660	•					
Transfer the basket to the factory		16	2.63		•				
Take out the roses from basket			0.37	•					
count the roses	125		1.92	•					
Basket wight measurment			0.17	•					by using manual scale
Put the roses into the basket	250		0.29	•					
Basket wight measurment			0.17	•					by using manual scale
Put the roses into the basket	500		0.03	•					
Basket wight measurment			0.16	•					by using manual scale
Put the roses into the basket	1000		0.07	•					
Carry out the basket			0.03	•					
Empty the contents of basket into bag			0.04	•					
Storage the bags	13		0.12					•	
Transfer the bags to the pot		7	0.08		•				
Empty the contents of bag (1) into the pot	1		0.2	•					
Make sure the roses fill the pot well			0.03				•		by using hands
Empty the contents of bag (2) into the pot	1		0.21	•					
Make sure the roses fill the pot well			0.56				•		by using hands
Empty the contents of bag (3) into the pot	1		0.25	•					
Make sure the roses fill the pot fully			0.08				•		by using hands
Carry bottle of Rose water	1		0.13	•					
Poured bottle of Rose water into pot			0.5	•					
Hold the cap			0.15	•					
install the cap			0.09	•					
make sure the cap well installed			0.02				•		
Bring a tabe	2	5	0.16		•				
welding behind of cap with tabe(first layer)			0.05	•					by using hands
welding the behind of cap with tabe(second layer)			0.1	•					by using hands
welding the bellow cap with tabe (first layer)			0.13	•					by using hands
welding the bellow cap with tabe (second layer)			0.22	•					by using hands
Ignite the fire			0.1	•					by using lighter
Adjust the fire scale			0.22				•		
Wait until the distillation process is finished			960			•			
Separation of rose oil			0.23	•					by using needle aspirator
Pour the oil rose content			0.06	•					
Storage the finished product			5.6					•	

Figure 2. Flow Process Chart

When we take a quick look at the chart, we will notice several steps being repeated, so for that we need to develop the process in order to eliminate waste.

We have chosen some improvements that can be applied to the process, they are:

- Putting a scale on the basket
- Using a holder around the pot neck

- Adding tube during the process of pouring
- Using 3 needle aspirator instead of 1

All these improvements will change the total of activities to be 29 instead of 39, saving the time to be 1633.41 minutes instead of 1637.76, and reduce distance to 37 meters as shown in the table 1 below

Table 1. Summary table of flow process chart

Flow Process Chart		Worker/Material/Equipment Type		
Chart No. 1 Sheet No. 1				
Subject charted: work study of Taif Roses' perfume manufacturing process	Activity	Present	Proposed	saving
Activity: Taif Roses' perfume manufacturing process	Operation O	27	20	7
	Transportation ⇨	4	3	1
	Delay D	1	1	0
Method: Present/Proposed	Inspection □	5	3	2
Location: Al-kamal factory, Taif	Storage ▽	2	2	0
Operative(s): Worker Clock No. 10;30 AM				
	Total	39	29	10
Charted by: Samar Alharthi Date: 19/4/2022	Distance (m)	44	37	
	Time (min)	1637.76	1633.41	4.35
Approved by: Lojain Alsufyani Date: 19/4/2022	Cost			

1.1.2.3. Multiple Activity Chart

The Multiple Activity Chart, Figure 2 enables us to determine the relationship between the operator(s) and the machine(s). In our case study, there are three operators and only one machine. Through the chart, we can clearly see the times when the operators and the machine are in either working or idle status.

Operation / Part		Summary	Man 1	Man 2 & 3	Machine
Operator Name	Unknown	work time	962.93	0.69	960
Analyst	Lojain Mohammad Alsufyani	idle time	960.69	962.24	2.93
Date	44669	cycle time	962.93	962.93	962.93
Method:	Present P	utilization ratio	0.002326233	0.000716563	0.996957

Working	
Idle	

Scale	operator1	State	time for operator 1 (min)	operators 2 & 3	State	time for operators 2&3 (min)	machine	State	time for machine (min)
	Description		Time	Description		Time	Description		Time
0.2	filling the pot with roses		0.2	idle		0	idle		0
0.23	press the roses to remove spaces		0.03	idle		0	idle		0
0.44	filling the pot with roses		0.21	idle		0	idle		0
1	press the roses to remove spaces		0.56	idle		0	idle		0
1.25	filling the pot with roses		0.25	idle		0	idle		0
1.33	press the roses to remove spaces		0.08	idle		0	idle		0
1.83	add rose water		0.5	idle		0	idle		0
1.92	close the pot		0.09	idle		0	idle		0
1.96	idle		0	close tightly using the tabe (behind)		0.04	idle		0
2.01	idle		0	pick another tabe		0.05	idle		0
2.1	idle		0	close tightly using the tabe (behind)		0.09	idle		0
2.16	idle		0	close tightly using the tabe (below)		0.06	idle		0
2.25	idle		0	pick another tabe		0.09	idle		0
2.31	idle		0	close tightly using the tabe (below)		0.06	idle		0
2.4	idle		0	pick another tabe		0.09	idle		0
2.61	idle		0	close tightly using the tabe (below)		0.21	idle		0
2.93	turn on the fire		0.32	idle		0	idle		0
962.93	idle		0	idle		0	distillation process		960

Figure 3. Multiple activity chart

The calculations used in the summary table using excel functions for work time are the sum of the work time for the individual workers and the machine. For example, the work time for the machine is cell: (=J26). Meanwhile, the idle time formula is the sum of the idle time for the individual workers and machines. That is the idle time for the machine is (=SUM(D9:D16,D25,G17:G24)). However, cycle time is the cumulative time for all operations and its cell is (=SUM(D26+G26+J26)+SUM(A25)). The utilization ratio shows the productive time by simply dividing the work time by the cycle time. From table 2 we can conclude that most of the work is done by men which makes it a really hard process to perform since the process of filling the pot is an extended process with almost no need for steps that could be eliminated or replaced with other alternatives.

Table 2. Summary table Multiple activity chart

Subject	Cycle time (min)	Working time	Idle time	Percentage utilisation
Operator 1	962.93	2.24	960.69	0.23%
Operator 2&3	962.93	0.69	962.24	0.000716563
Machine	962.93	960	2.93	0.996957204

1.1.2.4. Flow Diagram

The flow diagram Figure 4 shows the path followed by the material by a flow line for manufacturing of two products: Taif Roses' perfume (pink line) and Taif Roses' Water (light blue line). The direction of movement is shown by small arrows along the flow lines. The different activities are represented by the symbols on the flow lines to identify the different activities at different work centers. The layout is sketched based on measurements token in the factory and drawn using AutoCAD.

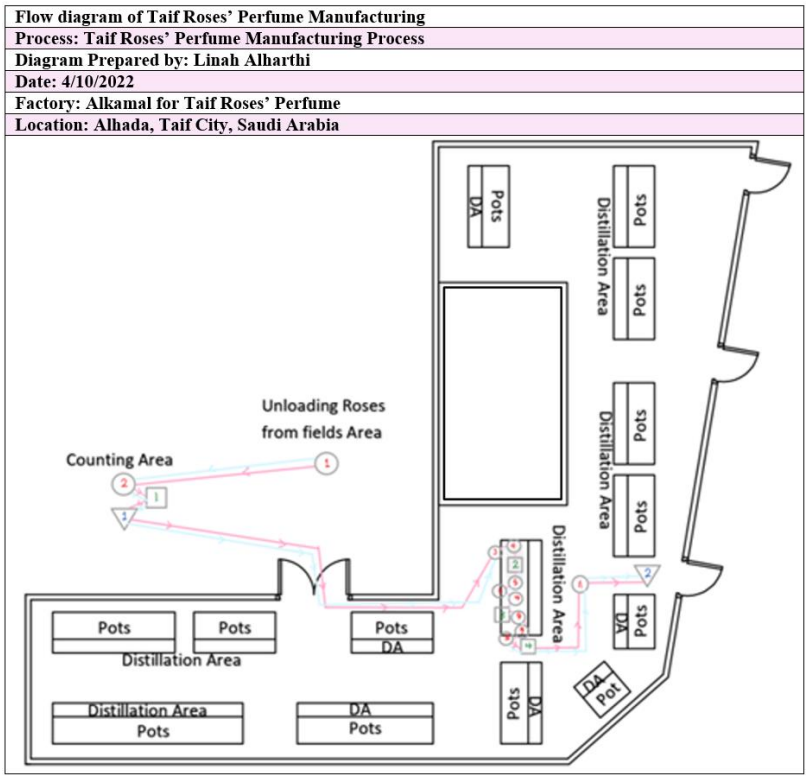

Figure 4. Flow diagram of Taif Roses' Perfume Manufacturing

The diagram presents the layout of the facility and the flow of the workplace area which has a smooth direct way. The stored materials are stored near its usage. It also shows a congestion or an overcrowding area in the pots area, but this is an essential part of the process, yet this can be modified to simplify the process. The possible modification Figure 5 is to widen the work area by expanding the spaces. Another possible modification is to unify ovens for each unit, this would save more time and reduce the number of tasks performed. We Might as well try the usage of the unused room; this would yield with more spacious full capacity factory.

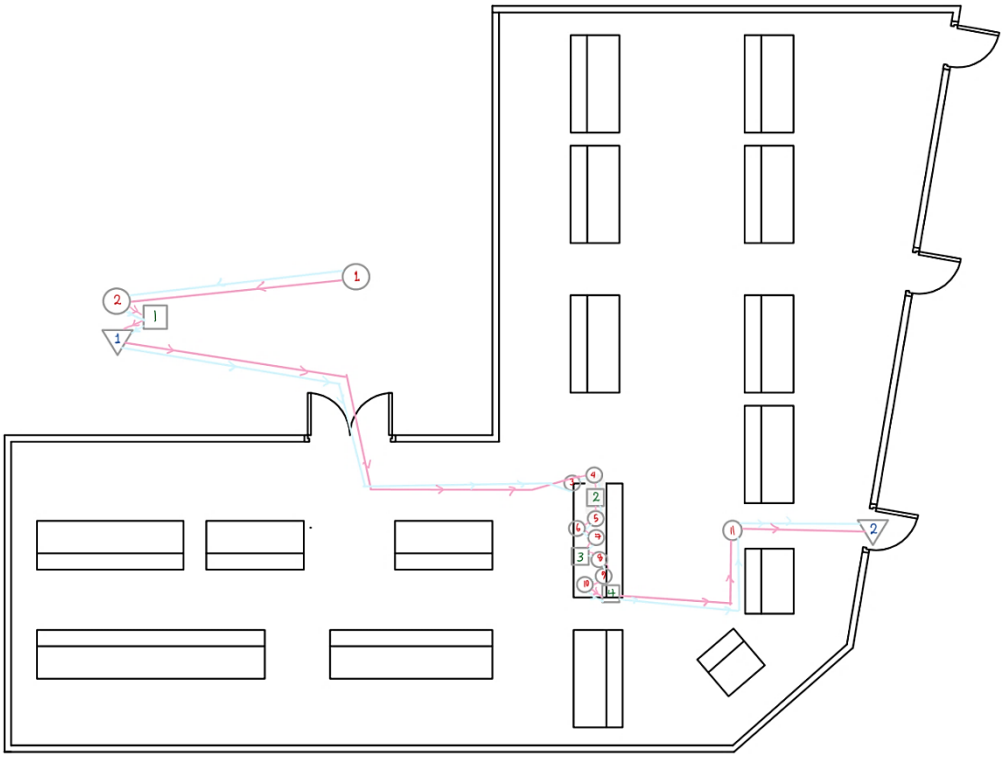

Figure 5. Modified Flow diagram of Taif Roses' Perfume Manufacturing

1.1.2.5. Examine

Examine step focuses on testing the facts critically. This is a key step in the whole process of work study. The information available in the form of chart and graphs after the recording step is thoroughly studied and analyzed in order to detect the production stages where improvement in the method is possible. This is achieved by questioning the different activities of the process in a systematic logical and objective manner. We have two types of questions to answer, the first is the primary questions and the other one is the secondary questions.

1.1.2.6. Primary questions

By answering the Primary questions, it shows up the necessity of carrying out the activity.

The use of questioning sequence follows a well-established pattern which examine the following

a) Purpose: what should be done?

We should eliminate the repetitive tasks and operations to achieve desired goal.

b) Place: where should it be done?

We should examine the place well and start to re-arrange and combine between the activities to put each of them in suitable place.

It should be done in one place.

c) Sequence: when should it be done?

There is a certain method and sequence that must be followed because it's the only way can be done.

d) Person: who should do it?

It is done by a staff specializing in the manufacture of rose perfume.

e) Means: how should it be done?

We are looking to simplify and facilitate the operation by analyzing each process and seeing if we can combine those processes or eliminate some of them, but the sequence of operations must be taken into account because any change in sequence may lead to opposite results.

1.1.2.7. Secondary questions

Answering the secondary questions allow us to determine whether possible to alternative methods of doing the activity to be practical and preferable.

a) Purpose: Since we have sufficient information about the operations, each process will be scrutinized and considering, the possibility of combine or re-arranging those operations to become a single operation or to be completed in one place (the operations of calculating and weighing roses can be combined by preparing a basket with a scale).

b) Place: each operation must be done on suitable place, re-arrange the workplaces will make it more efficient and faster.

c) Sequence: there is a certain method that must be followed, and it is divided into several stages. There are several stages that must be completed before moving to the next stage. Some of the steps can be combined and done together.

d) Person: It is done by a staff specializing in the manufacture of rose perfume, each crew member is responsible for a specific location.

Means: it is done in a certain method and sequence, but we combine several tasks and use some improvements that help save time and effort and reduce error.

1.1.2.8. Develop

After implementing recording techniques, the issues in the process that need to be modified are clear. Based on that, we suggested some developments in the process.

1) Putting a scale on the baskets .This will result in saving time on counting phase.

2) Smart self-closing lids .Through it, you can find out temperature also, timer It helps in reducing the time wasted in the process of wrapping using tape, in addition to being a suitable alternative if the tape runs out.

3) Using a holder around the pot neck. It helps reduce commute time and reduces the error that may occur because of the flowers falling out of the pot, which maintains the time required to complete this process.

4) Adding tube during the process of pouring. The cross-sectional area of the tube has inverse relationship with the flow velocity which helps quick the process and saving time.

5) Unified oven for each cell (unit) Each cell or area (unit) would have a unified oven. So, when operating to turn the oven on. Each cell's oven is turned on at once instead of turning the ovens solely for each pot.

6) 3 needle aspirators instead of 1 3 rubber needles will finish this process at a speed equal to 3 times better than before. Thus, a large number of bottles that end at the same time in the process of extracting rose oil (perfume).

From the developments above, our choice settled on the most applicable developments that would be easy to implement with the minimum cost and effort. The developments chosen are:

- Putting a scale on the basket:

This result in combining 6 operations (counting the roses and weighting measurements for each basket) to be one single operation, so it saves the time by 2.72 minutes and free some worker.

- Using a holder around the pot neck:

This helps reduce commute time and reduces the error that may occur because of the flowers falling out of the pot bags and saving time by 1.36.

- Adding a tube during the process of pouring:

This helps quick the process of pouring bottle of Rose water into pot by saving 0.2 minutes of time.

- Using 3 needle aspirator instead of 1:

This effects the time of separation of rose oil by 0.07 minutes.

All these improvements will change in the total of activities to be 29 instead of 39, saving the time to be 1633.41 minutes instead of 1637.76, and reduce distance to 37 meters.

1.2. Work Measurement

The aim of work measurement is determining the time necessary to perform the process and its elements so work and productivity are quantitatively measured.

The main objectives of work measurement application include:

- Comparing the times of performance by alternative methods.
- Enabling realistic schedule of work to be prepared.
- Arriving at a realistic and fair incentive scheme.

- Minimize the human effort.

In this study, we utilized filming and stopwatch techniques to perform the work measurement procedure on the manufacturing of Taif Roses' perfume.

1.2.1. Defining Work Measurement Procedure

Work measurement is the application of techniques designed to establish the time taken for a qualified worker to carry out a specified job at a defined level of performance. Mainly, the goal is to determine the time necessary to perform the process and its elements so work and productivity are quantitatively measured.

Work measurement is concerned with the investigation and reduction of any ineffective time associated with existing job, subsequent establishment of standard time for the operation which have been improved by method study, as well as the measurement of work required to complete a job with the application of different techniques to measure the time which is allotted to worker at a defined level of performance.

The procedure taken in work measurement is as follows:

- Select (Perfume manufacturing is selected, defined, and divided into small work elements).
- Obtain and record (the recording is done using filming and stopwatch).
- Examination of collected data.
- Measure the time duration.
- Extend calculations.
- Develop allowance.
- Calculate the standards time for the operation for the defined job.

1.2.2. Work Measurement Calculations

The values and the calculations made and recorded in Table 3, 4 report meaningful information. For instance, the performance rate report that the worker's observed time is equal to the time the work is done by a qualified worker. However, each member observed the process from her perspective and note it down, then we calculated the average and multiplied it by the performance rate to find the basic time of the work.

From our observation, we concluded that the work time is flexible whereas different works are assigned to specific workers, and the work has few process steps.

The subsequent calculations are essential calculations that we used in the table:

- Basic time = average observed time $*$ performance rate (1)
- Standard time = $\frac{basic\ time}{1-allowance\ factor}$ (2)

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Table 3. Work Measurement Calculations before modified

short cycle time study form

Department: Industrial Engineering | Selection: 1 | Study No.: 1
Operation: Taif Roses oil exract | MS No.: 1 | Sheet No.: 1 Of 1
Part/Machine | No.: 1 | Time of:
Tools and gauges: Degital stop watch | | Time on:
Product/Part: | No.: 1 | Elapsed time:
DWG No.: 1 | Material: Mainly Taif Rose water | Operative: Multiple workers
Quality: High | | Clock No.: 10:30:00 AM
| | Studied by: Team members
| | Date: 18 Apr. 2022
| | Checked:

EL No.	Element decribtion	Observed Time (OT)				Total (OT)	Avg. (OT)	PR	BT	% Allw	Standard Time
		1	2	3	4						
1	Bring basket from basket area	0.04	0.04	0.05	0.03	0.16	0.04	100%	0.04	7%	0.043
2	Move to the field of roses	2.42	2.4	2.4	2.41	9.63	2.4075	100%	2.4075	7%	2.589
3	Wear gloves	0.13	0.14	0.12	0.13	0.52	0.13	100%	0.13	7%	0.140
4	Picking roses (Picking process)	660	660	660	660	2640	660	100%	660	7%	709.677
5	Transfer the basket to the factory	2.63	2.62	2.6	2.61	10.46	2.615	100%	2.615	7%	2.812
6	Take out the roses from basket	0.37	0.36	0.35	0.37	1.45	0.3625	100%	0.3625	7%	0.390
7	count the roses	1.92	1.9	1.9	1.92	7.64	1.91	100%	1.91	7%	2.054
8	Basket wight measurment	0.17	0.15	0.16	0.15	0.63	0.1575	100%	0.1575	7%	0.169
9	Put the roses into the basket	0.29	0.27	0.26	0.29	1.11	0.2775	100%	0.2775	7%	0.298
10	Basket wight measurment	0.17	0.15	0.16	0.17	0.65	0.1625	100%	0.1625	7%	0.175
11	Put the roses into the basket	0.03	0.01	0.02	0.03	0.09	0.0225	100%	0.0225	7%	0.024
12	Basket wight measurment	0.16	0.14	0.15	0.16	0.61	0.1525	100%	0.1525	7%	0.164
13	Put the roses into the basket	0.07	0.06	0.05	0.07	0.25	0.0625	100%	0.0625	7%	0.067
14	Carry out the basket	0.03	0.01	0.02	0.03	0.09	0.0225	100%	0.0225	7%	0.024
15	Empty the contents of basket into bag	0.04	0.03	0.03	0.04	0.14	0.035	100%	0.035	7%	0.038
16	Storage the bags	0.12	0.11	0.1	0.12	0.45	0.1125	100%	0.1125	7%	0.121
17	Transfer the bags to the pot	0.08	0.07	0.06	0.08	0.29	0.0725	100%	0.0725	7%	0.078
18	filling the pot with roses	0.2	0.2	0.1	0.1	0.6	0.15	100%	0.15	7%	0.161
19	press the roses to remove spaces	0.03	0.05	0.06	0.04	0.18	0.045	100%	0.045	7%	0.048
20	filling the pot with roses	0.21	0.2	0.2	0.21	0.82	0.205	100%	0.205	7%	0.220
21	press the roses to remove spaces	0.56	0.53	0.55	0.56	2.2	0.55	100%	0.55	7%	0.591
22	filling the pot with roses	0.25	0.25	0.25	0.25	1	0.25	100%	0.25	7%	0.269
23	press the roses to remove spaces	0.08	0.07	0.08	0.07	0.3	0.075	100%	0.075	7%	0.081
24	add rose water	0.5	0.6	0.5	0.6	2.2	0.55	100%	0.55	7%	0.591
25	Hold the cap	0.15	0.14	0.13	0.12	0.54	0.135	100%	0.135	7%	0.145
26	install the cap	0.09	0.08	0.09	0.08	0.34	0.085	100%	0.085	7%	0.091
27	make sure the cap well installed	0.02	0.02	0.01	0.01	0.06	0.015	100%	0.015	7%	0.016
28	close the pot	0.09	0.1	0.1	0.09	0.38	0.095	100%	0.095	7%	0.102
29	close tightly using the tabe (behind)	0.04	0.05	0.06	0.05	0.2	0.05	100%	0.05	7%	0.054
30	pick another tabe	0.05	0.06	0.05	0.07	0.23	0.0575	100%	0.0575	7%	0.062
31	close tightly using the tabe (behind)	0.09	0.1	0.08	0.1	0.37	0.0925	100%	0.0925	7%	0.099
32	close tightly using the tabe (below)	0.06	0.13	0.06	0.07	0.19	0.0475	100%	0.0475	7%	0.051
33	pick another tabe	0.09	0.07	0.07	0.09	0.32	0.08	100%	0.08	7%	0.086
34	close tightly using the tabe (below)	0.06	0.15	0.04	0.06	0.16	0.04	100%	0.04	7%	0.043
35	pick another tabe	0.09	0.06	0.07	0.09	0.31	0.0775	100%	0.0775	7%	0.083
36	close tightly using the tabe (below)	0.21	0.22	0.2	0.21	0.84	0.21	100%	0.21	7%	0.226
37	turn on the fire	0.32	0.33	0.3	0.33	1.28	0.32	100%	0.32	7%	0.344
38	adjust the fire	0.22	0.2	0.21	0.22	0.85	0.2125	100%	0.2125	7%	0.228
39	waiting for the distillation process	960	960	960	960	3840	960	100%	960	7%	1032.258
40	Separation of rose oil	0.23	0.23	0.22	0.2	0.88	0.22	100%	0.22	7%	0.237
41	Pour the oil rose content	0.06	0.06	0.04	0.05	0.21	0.0525	100%	0.0525	7%	0.056
42	Storage the finished product	5.6	5	5.5	5.3	21.4	5.35	100%	5.35	7%	5.753
EL: Elements, OT: Observed Time, BT: Basic (normal) Time, Avg. (OT): Average Observed Time, %Allw: Percent Allowance										Total ST	1760.76

Table 4. Work Measurement Calculations after modified

short cycle time study form

Department: Industrial Engineering | Selection: 1 | Study No.: 1
Operation: Taif Roses oil exract | MS No.: 1 | Sheet No.: 1 Of 1
Part/Machine | No.: 1 | Time of:
Tools and gauges: Degital stop watch | | Time on:
Product/Part: | No.: 1 | Elapsed time:
DWG No.: 1 | Material: Mainly Taif Rose water | Operative: Multiple workers
Quality: High | | Clock No.: 10:30:00 AM
| | Studied by: Team members
| | Date: 18 Apr. 2022
| | Checked:

EL No.	Element decribtion	Observed Time (OT)				Total (OT)	Avg. (OT)	PR	BT	% Allw	Standard Time
		1	2	3	4						
1	Bring basket from basket area	0.04	0.04	0.05	0.03	0.16	0.04	100%	0.04	7%	0.043
2	Move to the field of roses	2.42	2.4	2.4	2.41	9.63	2.4075	100%	2.4075	7%	2.589
3	Wear gloves	0.13	0.14	0.12	0.13	0.52	0.13	100%	0.13	7%	0.140
4	Picking roses (Picking process)	660	660	660	660	2640	660	100%	660	7%	709.677
5	Transfer the basket to the factory	2.63	2.62	2.6	2.61	10.46	2.615	100%	2.615	7%	2.812
6	Take out the roses from basket	0.37	0.36	0.35	0.37	1.45	0.3625	100%	0.3625	7%	0.390
7	Put the roses into the basket	0.29	0.27	0.26	0.29	1.11	0.2775	100%	0.2775	7%	0.298
8	Carry out the basket	0.03	0.01	0.02	0.03	0.09	0.0225	100%	0.0225	7%	0.024
9	Empty the contents of basket into bag	0.04	0.03	0.03	0.04	0.14	0.035	100%	0.035	7%	0.038
10	Storage the bags	0.12	0.11	0.1	0.12	0.45	0.1125	100%	0.1125	7%	0.121
11	filling the pot with roses	0.2	0.1	0.1	0.1	0.5	0.125	100%	0.125	7%	0.134
12	filling the pot with roses	0.21	0.1	0.2	0.21	0.72	0.18	100%	0.18	7%	0.194
13	filling the pot with roses	0.25	0.2	0.23	0.25	0.93	0.2325	100%	0.2325	7%	0.250
14	add rose water	0.48	0.5	0.49	0.6	2.07	0.5175	100%	0.5175	7%	0.556
15	Hold the cap	0.15	0.14	0.13	0.12	0.54	0.135	100%	0.135	7%	0.145
16	install the cap	0.09	0.08	0.09	0.08	0.34	0.085	100%	0.085	7%	0.091
17	make sure the cap well installed	0.02	0.02	0.01	0.01	0.06	0.015	100%	0.015	7%	0.016
18	close the pot	0.09	0.1	0.1	0.09	0.38	0.095	100%	0.095	7%	0.102
19	close tightly using the tabe (behind)	0.04	0.05	0.06	0.05	0.2	0.05	100%	0.05	7%	0.054
20	pick another tabe	0.05	0.06	0.05	0.07	0.23	0.0575	100%	0.0575	7%	0.062
21	close tightly using the tabe (behind)	0.09	0.1	0.08	0.1	0.37	0.0925	100%	0.0925	7%	0.099
22	close tightly using the tabe (below)	0.06	0.13	0.06	0.07	0.19	0.0475	100%	0.0475	7%	0.051
23	pick another tabe	0.09	0.07	0.07	0.09	0.32	0.08	100%	0.08	7%	0.086
24	close tightly using the tabe (below)	0.06	0.15	0.04	0.06	0.16	0.04	100%	0.04	7%	0.043
25	pick another tabe	0.09	0.06	0.07	0.09	0.31	0.0775	100%	0.0775	7%	0.083
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27	turn on the fire	0.32	0.33	0.3	0.33	1.28	0.32	100%	0.32	7%	0.344
28	adjust the fire	0.22	0.2	0.21	0.22	0.85	0.2125	100%	0.2125	7%	0.228
29	waiting for the distillation process	960	960	960	960	3840	960	100%	960	7%	1032.258
30	Separation of rose oil	0.23	0.23	0.22	0.2	0.88	0.22	100%	0.22	7%	0.237
31	Pour the oil rose content	0.06	0.06	0.04	0.05	0.21	0.0525	100%	0.0525	7%	0.056
32	Storage the finished product	5.6	5	5.5	5.3	21.4	5.35	100%	5.35	7%	5.753
EL: Elements, OT: Observed Time, BT: Basic (normal) Time, Avg. (OT): Average Observed Time, %Allw: Percent Allowance										Total ST	1757.20

2. RESULTS AND DISCUSSIONS

After conducting a work study on the current methods and analyzing them well, we obtained some results, and from this we reached a set of improvements. As the charts and diagram used in the recording step of method study indicate that there are some steps that are being repeated.

Therefore, we suggested several developments on the process in order to eliminate waste. The suggested developments include putting a scale on the basket of measuring roses, using a holder around the pot neck, adding tube during the process of pouring, and using 3 needle aspirators instead of 1 to extract the oil. Accordingly, the number of activities performed in the process decreased by 10 activities to have a total of 32, the amount of time reduced to be 1633.41 minutes instead of 1637.76, and the distance has been shortened by 7 meters to be 37 meters only. After that in the work measurement procedure the calculations yielded with a standard time of 1757.2 minutes.

The results indicate the success of the improvement proposals since they save time and effort for workers which would yield with an increase of productivity in the manufacturing process. Unfortunately, as that we are not authorized to access calculations of the cost, the results cannot determine the actual cost improvements. Yet, the estimated cost of applying the developments proposed is considered a reasonable cost and the resulting enhancements would compensate any costs of enhancements. They are economically beneficial, and the factory would thrive by implementing them. The application resulted of the proposal of enhancements that is reached after the conduction of work study would facilitate the methodology of the manufacturing and the efforts done in the process. The old manufacturing method was as follow: hand picking roses and collecting them in the basket, counting the roses using hands and weighing it with a scale. Then, the roses transferred from the basket to the bag, putting the roses in the pot and pressing by hand. After that, pouring rose water into the pot, manually closing the pot, sealing the pot using tape, turning on the oven for each pot, starting the distillation process and separating perfume from rose water using a needle with a single aspirator.

The proposed manufacturing method is hand picking roses and collecting them in a basket that have a scale on it with consideration to the type of roses where they are heavy of oil or light. This will result in saving time on counting phase. Weighing the basket with scale, the roses are transferred from the basket to the bag using the holder on the bags. It helps to carry load of roses bags by strong clips, reduce commute time and allows adding a vacant worker. Putting the roses in the pot by using holder around the neck of the pot. It helps reduce commute time and reduces the error that may occur because of the flowers falling out of the pot, which maintains the time required to complete this process. Then press the roses by hand and pour rose water into the pot while using a tube during the process of pouring which helps quick the process and saving time. Close the pot, seal the pot using tape, turn on the oven for each pot, start the distillation process and separating perfume from rose water using a three aspirators needle that help to finish this process at a speed equal to 3 times better than the previous way of extracting.The advantages of the proposed method and the improvements that have occurred summarized in save time and effort, implement the proposed method at a reasonable cost with high productivity using the above-mentioned proposed manufacturing method.

3. CONCLUSION AND RECOMMENDATIONS

Through the application of the work study represented in method study and work measurement, we investigated the operations that were performed before reaching the final product and the time taken to complete each process. We found the weaknesses that existed during the manufacturing period and suggested solutions that help reach a product of the same quality while increasing productivity. Our understanding of multiple aspects related to the Taif roses' perfume, the way it is manufactured, and what happens to its residue after the completion of the perfume-making process is completed.

Applying this study and investigating the process through our unique experience with our visit to the factory, and the monitoring of the process as well as the process recording its data by ourselves made a great impact. Some suggestions that we might recommend for further investigations are to continuously develop and thrive for the better methods in manufacturing this wholesome industry. Taif roses are a very special type of flowers. This is due to its unique positioning in the mountains with a higher location and milder climate, the roses are exceptionally fresh. Harvesting the delicate roses require to be handpicked early in the morning when the fragrance is at its purest. It takes between 10,000 and 15,000 roses to produce only a vial of essential oil (perfume). This labor-intensive process to obtain rose nectar is why it is so precious and sacred to Taif's people and identity. Subsequently, the persistent care and enhancement using scientific approached such as work study of this process that reflects our heritage is a need to keep the industry outstanding as we know it to be.

Conducting work study on a deep-rooted manufacturing and heritage in our city was a great opportunity to contribute to the community of our city through our studies. The developments suggested in our project would enhance the productivity of the process and would donate in the growth of the process as they are more efficient and sufficient for manufactures.

The approaches used in the study are part of Work Study techniques studied in the curriculum Work Study 8053203-3. Generally, applying work-study to a process means searching two main areas to enhance productivity. Method Study and Work Measurement. The goal of the first area is to examine the process and find more efficient methods of performance, so the process is simplified, and better ways are developed. We used flow process chart, multiple activity chart, flow diagram as the techniques to perform method study. In determining work measurement, the goal is to determine the time necessary to perform the process and its elements so work and productivity are quantitatively measured. This study used filming, stopwatch as the techniques to perform work measurement.

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Competing Interests Statement

The authors declare no competing financial, professional, or personal interests.

Consent for publication

The authors declare that they consented to the publication of this research work.

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